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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Aerosol–Cloud Closure Study on Cloud Optical Properties using Remotely Piloted Aircraft Measurements during a BACCHUS Field Campaign in Cyprus" *by* Radiance Calmer et al.

Anonymous Referee #2

Received and published: 18 June 2019

The manuscript by Calmer et al. shows results from an aerosol-cloud closure study based on ground-based and airbourne measurements complemented by a numerical cloud parcel model. The basic methods used in the investigation are sound. The numerical modelling framework seems rather simplistic, but is probably adequate to characterize the aerosol-cloud closure in the stratiform cloud case. Moreover, it is nice to see that the effect of entrainment on the aerosol-cloud coupling is considered, which comprises some of the more interesting aspects of the manuscript.

I'd like to ask the Authors to improve the presentation quality of the model description

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Discussion paper

and some of the results, which seem very confusing and hard to follow at times. Please see the specific comments for details.

In addition, I think the contribution by the simple sensitivity tests to the outcome of the manuscript is rather weak, since it is very clear from the basic analysis (as well as from other sources) that neglecting such a central physical process as entrainment will not yield a good aerosol-cloud closure in most cases. It would be more interesting to try characterize e.g. the possible feedback effects between the aerosol-cloud microphysical perturbations and entrainment. Other than the sensitivity tests, the manuscript does not touch on the subject of aerosol indirect effects specifically, and the sensitivity tests presented are not really enough to make any conclusions about AIE. I suppose the currently used model setup is not able to adjust entrainment in response to changes in the cloud radiative properties caused by changing droplet number etc.?

Specific comments:

Section 3: The model description is not adequate: is it actually a 1-D column model, or a (0-D) parcel model which you lift along a vertical trajectory? Where and how do you set the model top, do you limit it exactly at cloud top height? How long timestep do you use? Please be more precise and put some more effort to details.

Page 7, line 18: Aerosols are given in fixed bins, but what is the size range and spacing of the bins? The sentence on line 26 talks about the aerosol particles again, while the previous sentence is about liquid water in “moving section representation”? Please describe one issue at a time (i.e. aerosol bin characteristics, cloud droplet bin characteristics, the coupling between aerosol and cloud etc.) to make it easier to read and, again, try to make it consistent and precise.

Page 9, line 6:

Page 11, line 15: In reality, cloud albedo remains somewhat smaller than unity. This assumption does not seem legitimate.

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Section 4.3: Please declare the notation for the experiments (dw and dN) already in the beginning of the section to make it easier to read.

Section 4.3: Please check and revise the presentation of the results. First you state that halving the updraft velocity decreases the fraction of transmitted shortwave radiation. Do you mean increases, since this contradicts the change shown in Fig 14 as well as the general expectation, or do you change the point of reference from the control experiment to the dw experiment? In the latter case, please don't do that. Also, the reported total range of change seen in the transmitted fraction (dN effect as the low limit, dw effect as the high) then adds to this confusion.

Page 12, lines 28-29: "The lower cloud droplet number and smaller effective radii results in lower albedo" – do you mean larger effective radii? Does all this still refer to the dw experiment? Please clarify.

Page 14, line 18: Combining the range of variation in the cloud radiative properties from the dw and dN sensitivity experiments feels a bit awkward, since the perturbations used in the two quantities and their magnitudes have nothing to do with each other whatsoever. Please consider keeping the results from these sensitivity experiments separate.

Page 14, line 25: "... highlight notably that entrainment processes reduce the impact of cloud radiative forcing." Please reconsider this statement. This generalization is not the same thing as having biased model results because of neglecting this essential physical process. Instead, referring to the general comment in the beginning of this review, entrainment can react e.g. to aerosol induced changes in the cloud and create a feedback loop, but this is not investigated in the manuscript.

Technical comments

Figure 10: Please rephrase the caption; "number of particles greater than 0.3 um" etc.

Figure 11: Please rephrase the caption; "mass concentration and chemical composi-

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tion of aerosol during the flight ...” etc.

Figure 13: Please explain the shaded areas briefly in the caption.

Figure 14: The x-axis label is pretty confusing, try to simplify.

Page 3 lines 21-22 unclear sentence

Are the model code and data publicly available?

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2019-8, 2019.

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